CLAIMS

What is claimed is:

1. An ultrasonic transducer comprising:

a holder having at least two spaced apart cylindrical surfaces;

a cylindrical piezoelectric film spanning between the at least two spaced apart cylindrical surfaces of the holder;

an outer electrode segment disposed on an outer surface of the film; and

an inner electrode segment disposed on an inner surface of the film;

wherein the transducer radiating acoustic energy substantially along a longitudinal axis thereof in response to an excitation voltage applied to the film via the electrode segments.

2. The transducer of claim 1, further comprising a cover spaced from the outer surface of the film, the cover including a flange restricting propagation of the radiating acoustic energy along a propagation path defined along an exterior of the film.

3. The transducer of claim 2, further comprising a reflector disposed at an end thereof for redirecting the radiating acoustic energy in an opposite direction.

4. The transducer of claim 1, further comprising a reflector disposed at an end thereof for redirecting the radiating acoustic energy in an opposite direction.

5. The transducer of claim 1, wherein:

the at least two spaced apart cylindrical surfaces comprising a plurality of spaced apart cylindrical surfaces;

the film spanning between at least two pairs of the plurality of spaced apart cylindrical surfaces of the holder;

the outer electrode segment comprising a plurality of outer electrode segments; and

the inner electrode segment comprising a plurality of inner electrode segments.

6. The transducer of claim 5, further comprising a cover spaced from the outer surface of the film, the cover including a flange restricting propagation of the radiating acoustic energy along a propagation path defined along an exterior of the film.

7. The transducer of claim 6, further comprising a reflector disposed at an end thereof for redirecting the radiating acoustic energy in an opposite direction.

8. The transducer of claim 5, further comprising a reflector disposed at an end thereof for redirecting the radiating acoustic energy in an opposite direction.

9. A stylus comprising:

an elongated housing defining an internal bore and having an opening at an end thereof that communicates with the internal bore;

a writing and drawing implement disposed within the bore of the housing, the implement having a tip extending through the opening at the end of the housing; and

a transducer disposed within the bore, the transducer comprising:

a holder having at least two spaced apart cylindrical surfaces;

a cylindrical piezoelectric film spanning between the at least two spaced apart cylindrical surfaces of the holder;

an outer electrode segment disposed on an outer surface of the film; and

an inner electrode segment disposed on an inner surface of the film;

wherein the transducer radiating acoustic energy substantially along a longitudinal axis of the stylus in response to an excitation voltage applied to the film via the electrode segments such that the radiating acoustic energy propagates along the bore toward the end and exits at the opening.

10. The stylus of claim 9, further comprising a conical reflector disposed external to the opening, the tip of the implement extending through the conical reflector, the conical reflector responsive to the radiating acoustic energy for redirecting the radiating acoustic energy at an angle substantially perpendicular to the longitudinal axis of the stylus.

11. The stylus of claim 9, further comprising a cover spaced from the outer surface of the film, the cover including a flange restricting propagation of the radiating acoustic energy along a propagation path defined along an exterior of the film.

12. The stylus of claim 11, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

13. The stylus of claim 10, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

14. The stylus of claim 9, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

15. The stylus of claim 9, wherein:

the at least two spaced apart cylindrical surfaces comprising a plurality of spaced apart cylindrical surfaces;

the film spanning between at least two pairs of the plurality of spaced apart cylindrical surfaces of the holder;

the outer electrode segment comprising a plurality of outer electrode segments; and

the inner electrode segment comprising a plurality of inner electrode segments.

16. The stylus of claim 15, further comprising a conical reflector disposed external to the opening, the tip of the implement extending through the conical reflector, the conical reflector responsive to the radiating acoustic energy for redirecting the radiating acoustic energy at an angle substantially perpendicular to the longitudinal axis of the stylus.

17. The stylus of claim 15, further comprising a cover spaced from the outer surface of the film, the cover including a flange restricting propagation of the radiating acoustic energy along a propagation path defined along an exterior of the film.

18. The stylus of claim 17, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

19. The stylus of claim 16, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

20. The stylus of claim 15, further comprising a reflector disposed at an end of the transducer for redirecting the radiating acoustic energy toward the opening of the housing.

21. The transducer of claim 1, wherein the excitation voltage has a frequency which has a wavelength in a propagation medium, and a width of each of the electrode segments is about half of the wavelength.

22. The transducer of claim 21, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

23. The transducer of claim 1, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

24. The transducer of claim 5, wherein the excitation voltage has a frequency which has a wavelength in a propagation medium, wherein about half of the wavelength is more than a width of each of the electrode segments.

25. The transducer of claim 24, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

26. The transducer of claim 5, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

27. The stylus of claim 9, wherein the excitation voltage has a frequency which has a wavelength in a propagation medium, wherein about half of the wavelength is more than a width of each of the electrode segments.

28. The stylus of claim 27, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

29. The stylus of claim 9, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

30. The stylus of claim 15, wherein the excitation voltage has a frequency which has a wavelength in a propagation medium, wherein about half of the wavelength is more than a width of each of the electrode segments.

31. The stylus of claim 30, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

32. The stylus of claim 15, further comprising a drive circuit for sequentially applying the excitation voltage to the electrode segments of the transducer.

33. The stylus of claim 9, wherein the holder is a defined by a section of the implement which is disposed within the bore.

34. The stylus of claim 10, wherein the holder is a defined by a section of the implement which is disposed within the bore.

35. The stylus of claim 13, wherein the holder is a defined by a section of the implement which is disposed within the bore.

36. The stylus of claim 14, wherein the holder is a defined by a section of the implement which is disposed within the bore.

37. A stylus comprising:

an elongated housing having an interior, an opening at an end thereof and at least one bore extending between the interior and the opening;

a writing and drawing implement disposed within the housing, the implement having a tip extending through the opening at the end of the housing; and

at least one transducer disposed within the interior of the housing, the transducer comprising:

a flat diaphragm;

a piezoelectric layer disposed on a surface of the diaphragm;

an outer electrode segment disposed on an outer surface of the piezoelectric layer; and

an inner electrode segment disposed on an inner surface of the piezoelectric layer;

wherein the transducer radiating acoustic energy substantially along a longitudinal axis of the housing in response to an excitation voltage applied to the piezoelectric layer via the electrode segments such that the radiating acoustic energy propagates along the at least one bore toward the end and exits at the opening.

38. The stylus of claim 37, wherein the at least one transducer is disposed within the interior of the housing in a position substantially perpendicular to the longitudinal axis of the housing.

39. The stylus of claim 37, wherein the at least one transducer is disposed within the interior of the housing in a position substantially parallel with the longitudinal axis of the housing.

40. The stylus of claim 37, wherein the implement extends through at least a portion of the at least one bore.

41. The stylus of claim 37, wherein the at least one bore has a diameter which remains substantially constant along its length.

42. The stylus of claim 37, wherein the at least one bore has a diameter which progressively increases from the opening toward the interior.

43. The stylus of claim 37, wherein the at least one transducer comprises at least one pair of opposing transducers.

44. The stylus of claim 43, wherein the at least one pair of opposing transducers are each disposed within the interior of the housing in a position substantially parallel with the longitudinal axis of the housing.

45. The stylus of claim 37, wherein the at least one transducer comprises multiple pairs of opposing transducers.

46. The stylus of claim 45, wherein the multiple pairs of opposing transducers are each disposed within the interior of the housing in a position substantially parallel with the longitudinal axis of the housing.

47. The stylus of claim 39, wherein the at least one bore comprises two bores.

48. The stylus of claim 47, wherein the two bores have different path lengths.

49. The stylus of claim 43, wherein the at least one bore comprises three bores.

48. The stylus of claim 49, wherein one of the bores has a different path length than the other two bores.

49. The stylus of claim 39, wherein the at least one transducer comprises a plurality of transducers disposed in an inline array.

50. The stylus of claim 47, wherein the at least one transducer comprises a plurality of transducers disposed in an inline array.

51. The stylus of claim 39, wherein the at least one transducer further comprises at least a second outer electrode segment disposed on the outer surface of the layer and the inner electrode segment is formed as a common ground.

52. The stylus of claim 38, wherein the at least one transducer includes a centrally disposed aperture.

53. The stylus of claim 52, further comprising a blocking element disposed opposite a front surface of the at least one transducer.

54. The stylus of claim 38, further comprising a blocking element disposed opposite a front surface of the at least one transducer.

55. The stylus of claim 38, wherein the implement is longitudinally moveable between a first position where the implement does not contact the diaphragm of the at least one transducer and the at least one transducer does not radiate acoustic energy, and a second position where the implement contacts the diaphragm of the at least one transducer when a force is applied to the tip of the implement during contact with a surface, and the at least one transducer radiates acoustic energy.

56. The stylus of claim 49, wherein the outer electrode segments of the transducers are commonly connected to one of a positive terminal and a ground terminal of an AC drive source and the inner electrode segments of the transducers are commonly connected to the other of the positive and the ground terminal of the AC drive source.

57. The stylus of claim 56, wherein the transducers in the inline array have alternating polarities.

58. The stylus of claim 49, wherein alternating ones of the outer electrode segments of the transducers are commonly connected to one of a positive terminal and a ground terminal of an AC drive source, alternating ones of the inner electrode segments of the transducers are commonly connected to the other of the positive and the ground terminal of the AC drive source, alternating remaining ones of the outer electrode segments of the transducers are commonly connected to the other one of a positive terminal and a ground terminal of an AC drive source, and alternating remaining ones of the inner electrode segments of the transducers are commonly connected to the one of the positive and the ground terminal of the AC drive source.

59. The stylus of claim 58, wherein the transducers in the inline array have same polarities.

60. The stylus of claim 49, each of the transducers is driven by a driver having a time delay of drive voltage, corresponding to the propagation time of the acoustic signal output from a given one of the transducers to a next adjacent one of the transducers.

61. The transducer of claim 1, wherein the holder restricts propagation of the radiating acoustic energy along a propagation path defined within an interior of the film.

62. The transducer of claim 5, wherein the holder restricts propagation of the radiating acoustic energy along a propagation path defined within an interior of the film.

63. The stylus of claim 9, wherein the holder restricts propagation of the radiating acoustic energy along a propagation path defined within an interior of the film.

64. The stylus of claim 15, wherein the holder restricts propagation of the radiating acoustic energy along a propagation path defined within an interior of the film.

65. The stylus of claim 39, wherein the at least one transducer comprises a plurality of piezoelectric layer segments disposed in an inline array.

66. The transducer according to claim 5, wherein the electrode segments have a center to center distance of one-half of a wavelength and the electrode segments are driven such that every other one is driven in-phase with every adjacent electrode segment in opposite phase drive.

67. The stylus of claim 65, wherein the electrode segments have a center to center distance of one-half a wavelength, with adjacent electrode segments in opposite phase drive.

68. The transducer of claim 1, wherein the excitation voltage has a frequency which has a wavelength in a propagation medium, and a width of each of the electrode segments is about 10 to 20 percent greater that one-half the wavelength.